

FOOD AND FEEDING HABITS OF *RANA HEXADACTYLA* LESSON³ IN KUTTANAD, KERALA¹

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The food and feeding habits of *Rana hexadactyla* were studied at Kuttanad, Kerala. Arthropods formed the major food items of the species, with insects which were of economic importance being the primary food.

INTRODUCTION

The stomach contents of many species of anura have been examined to determine their role in an ecosystem. The food of different anuran species inhabiting temperate regions have been studied by several workers (Needham 1905, Drake 1914, Smith 1953, Tyler 1958, Brooks 1959, Berry 1965, 1970; Jensen and Klimstra 1966, Blackith and Speight 1974). However, the food and feeding habits of only a few tropical species have been investigated (Khera 1975, Issac and Rege 1975, Nigam 1979, Battish and Sandhu 1988, Battish *et al.* 1989, Sreelatha *et al.* 1990). *Rana tigerina* is known to play a significant role in controlling agricultural pests (Abdulali 1985). The food and feeding habits of *Rana hexadactyla* are not fully known (Chacko and Krishnamurthy 1951, Mondal 1970, Andrews 1979).

Kuttanad, a natural wetland in Kerala, is an ideal habitat for frogs, especially *Rana hexadactyla*. This region being the 'rice bowl' of Kerala produces one-third of the total rice cultivated in the State. The present study is an effort directed not only towards collecting data on the natural diet of the Indian green frog *Rana hexadactyla* but also towards determining the role it plays in the Kuttanad ecosystem.

MATERIAL AND METHODS

The stomach content analysis of *Rana hexadactyla* was carried out from January 1988 to December 1989. A total of 408 frogs (102 males and 306 females) were used in the present study.

Adult frogs were collected from the paddy fields of Kuttanad during night and killed immediately in the laboratory. Their body weight was recorded and the stomachs removed and preserved in 10% formalin. Stomach contents were taken in a petri dish after incising the stomach longitudinally. The stomach and stomach contents were weighed, and the contents examined under a binocular dissecting microscope.

TABLE I
STOMACH CONTENTS OF *R. hexadactyla* EXPRESSED AS PERCENTAGE OF TOTAL BODY WEIGHT WITH RESPECT TO SEX AND MONTH

Month	Sex	
	Male	Female
January	2.03	1.76
February	0.50	0.44
March	0.94	0.15
April	3.46	1.29
May	1.07	1.11
June	0.45	0.74
July	2.11	1.49
August	0.71	0.48
September	0.30	2.61
October	0.82	0.44
November	0.96	0.90
December	2.14	1.49

RESULTS

The monthly distribution of stomach contents expressed as percentage of total body weight with respect to sex and month is shown in Table 1. Males seem to consume more food than females, except in the months of May, June and September. The frog

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³*Rana hexadactyla* is presently *Occidozyga hexadactyla* (Lesson, 1834). The classification of Indian Amphibia has undergone several changes, for details see S.K. Dutta (1992), *Hamadryad*, pp. 1-13.

TABLE 2

FOOD SPECTRUM OF *Rana hexadactyla* LESSON

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Annelida			
Class: Oligochaeta			
Order: Opisthopora			
Family: MEGASCOLECIDAE			
<i>Megascolex sp.</i>	18	36	
Arthropoda			
Class: Insecta			
Order: Anisoptera			
Dragonfly	61	74	Carnivorous, predator
Dragonfly nymph	74	83	"
Order: Dermaptera			
Family: LABIDURIDAE			
<i>Labidura riparia</i>	18	22	Carnivorous
<i>Anisolabis sp.</i>	14	18	
Family: FORFICULIDAE			
<i>Forficula sp.</i>	24	33	
Family: CARCINOPHORIDAE			
<i>Euborellia sp.</i>	19	27	Root pest
Order: Orthoptera			
Family: GRYLLOTALPIDAE			
<i>Grylotalpa fossor</i>	209	281	Paddy pest
<i>Gryllopsis sp.</i>	43	59	
Family: TRIDACTYLIDAE	1	2	
Family: GRYLLIDAE			
<i>Gymnogryllus sp.</i>	97	111	Omnivorous
<i>Gryllus sp.</i>	237	296	"
Family: ACRIDIDAE			
<i>Oxya hyla hyla</i>	132	184	Harmful to paddy
<i>Spathosternum calignosum</i>	4	12	"
<i>Hieroglyphus banian</i>	81	158	
<i>Tryxalis sp.</i>	6	18	
<i>Scelimena sp.</i>	12	19	
Order: Hemiptera			
Family: BELOSTOMATIDAE			
<i>Spherodema rusticum</i>	43	79	Carnivorous water bugs
<i>S. annulatum</i>	212	369	"
<i>Diplonyctus sp.</i>	1	1	

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Family: JASSIDAE			
<i>Nephotettix sp.</i>	9	18	Harmful to crops
Family: GERRIDAE			
<i>Gerris sp.</i>	19	36	Water skaters
Family: HYDROMETIDAE	1	2	
Order: Lepidoptera			
Noctuid larva	18	27	Crop pest
Caterpillar	18	39	"
Hesperiid larva	7	11	"
Order: Blattaria			
Family: BLATTIDAE			
<i>Periplaneta americana</i>	9	12	Household pest
Order: Diptera			
Family: CULICIDAE			
<i>Anopheles sp.</i>	47	189	Vector
Family: CHIRONOMIDAE			
<i>Chironomus larva</i>	11	18	Fish food
Family: MUSCIDAE			
<i>Musca sp.</i>	3	8	Household pest
Family: SARCOPHAGIDAE			
<i>Parasarcophaga sp.</i>	1	1	
Order: Hymenoptera			
Family: FORMICIDAE			
<i>Diacamma vagans</i>	5	8	Harmful to trees
<i>Odontomachus sp.</i>	1	1	"
<i>Camponautus compressus</i>	89	174	"
<i>Megachilla sp.</i>	24	69	"
Order: Coleoptera			
Family: CARABIDAE			
<i>Anoplogenus sp.</i>	39	74	Paddy pest
<i>Bembidion soborium</i>	28	61	
<i>Chlaenius sp.</i>	1	3	
<i>Dioryche sp.</i>	2	6	
<i>Siagona sp.</i>	4	8	
<i>Scarites sp.</i>	43	58	"
<i>Pheropsopheus catorei</i>	1	1	
<i>Clivina sp.</i>	1	1	
<i>Systolocranius sp.</i>	17	23	"
<i>Gnathophorus sp.</i>	1	2	
<i>Kareya sp.</i>	1	1	
<i>Abacetus sp.</i>	1	3	
<i>Pachytrachelus sp.</i>	1	1	

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance	Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Family: DYSTICIDAE				Class: Arachnida			
Cybister larva	12	18	Predacious	Order: Lycosidae			
Family: SCARABAEIDAE				<i>Paradosa songosa</i>	83	147	Biological control agent
<i>Anomaila dussumieri</i>	13	29	Root pest	<i>Paradosa bursantiensis</i>	79	116	"
<i>Anomaila chlorocarpa</i>	16	37	Pest of Cashew	<i>Paradosa</i> sp.	22	48	
<i>Autoserica insanabilis</i>	3	8	"	<i>Hippasa</i> sp.	20	43	
<i>Anserica</i> sp.	1	1		<i>Lycosa iranii</i>	3	12	"
<i>Mimela</i> sp.	1	2		<i>Lycosa sumatrana</i>	6	18	"
<i>Onthophagus</i> sp.	22	43	Crop pest	<i>Lycosa bistriata</i>	6	19	"
<i>Onitis</i> sp.	1	2		Family: TETROGNATHIDAE			
<i>Catharsius sagax</i>	1	1		<i>Tetrognatha</i> sp.	12	21	"
<i>Chiloloba</i> sp.	2	2		<i>Tetrognatha</i>			
<i>Allisonotum</i> sp.	2	3		<i>andamanensis</i>	94	167	"
<i>Sisyphus</i> sp.	3	4		<i>Tetrognatha mandibulata</i>	7	18	"
<i>Hybosorus</i> sp.	6	8		Family: ARANEIDAE			
<i>Holotrichia</i> sp.	4	6		<i>Neoscona legubris</i>	31	69	
<i>Heteronychus</i> sp.	5	18	Paddy pest	Family: HETROPODIDAE			
<i>Popilla</i> sp.	12	16		<i>Heteropoda</i> sp.	10	21	
Family: HYDROPHILIDAE				Class: Myriapoda			
<i>Sternolophus</i>	6	21	Pest stored food grain	Family: SCOLOPENDRIDAE			
<i>brachyacanthus</i>				<i>Otostigmus</i> sp.	4	7	
Hydrophilid sp.	2	8	Larva predacious	Millipede	11	16	
Family: ELATERIDAE				Mollusca			
<i>Melanotus hirticornis</i>	2	2	Pest of stored food grain	Class: Gastropoda			
<i>Heteroderis</i> sp.	1	1		Order: Basommatophora			
<i>Lema</i> sp.	1	1		Family: PLANORBIDAE			
<i>Attica</i> sp.	1	1		<i>Indoplanorbis exustus</i>	16	22	
Family: CURCULIONIDAE				Family: PILIDAE			
<i>Odioporus</i> sp.	2	2		<i>Pila</i> sp.	1	1	Useful
<i>Plococerus</i> sp.	1	1		Order: Systellommatophora			
<i>Sipalus</i> sp.	2	2	Crop pest	Family: VERONICELLIDAE			
<i>Xanthoprochilus</i> sp.	4	4		<i>Laevicaulis</i> sp.	1	1	
Family: TENEBRIONIDAE				Pisces			
<i>Gonocephalum</i> sp.	18	36	Paddy pest	Family: CYPRINIDONTIFORMES			
<i>Scleron</i> sp.	1	1		<i>Haplochilus punchax</i>	11	18	Larvivorous, biological control agent
<i>Mesomorphus</i> sp.	1	1		Family: CYPRINIFORMES			
<i>Hematismus</i> sp.	1	1		<i>Rasbora daniconius</i>	3	6	Edible fish
Family: COCCINELLIDAE				Family: PERCIFORMES			
<i>Coelophora</i> sp.	8	18		<i>Etroplus</i> sp.	1	1	"
Class: Crustacea				Amphibia			
Order: Decapoda				Order: Anura			
<i>Palaemon</i> sp.	17	36	Useful	Family: RANIDAE			
<i>Paratelpusa</i>				<i>Rana cyanophlyctis</i>	2	3	Useful
<i>bouvieri</i>	43	67	Serious paddy pest	<i>Rana hexadactyla</i>	1	1	Edible frog
<i>P. hydrodromus</i>	18	24	"				

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Reptilia			
Order: Opidia			
<i>Typhlops</i> sp.	1	6	Predator
Order: Squamata			
<i>Calotes</i> sp.	3	4	Predator
Stones, leaves and debris	—	Many	

feeds on a variety of animals belonging to 20 orders. The most predominant insect orders were Orthoptera, Coleoptera and Hemiptera (Table 2). Other than the insects, spiders and crabs were the main food items. Vegetable matter, stones and other debris were also found in most of the stomachs examined during the present study.

The economic importance of some of the food items is represented in Table 2. It is evident that *R. hexadactyla* is a natural predator of many of the agricultural pests, especially paddy pests found in Kuttanad. Many of the serious paddy pests like *Gryllotalpa fossor*, *Oxya hyla hyla*, *Hieroglyphus banian*, *Anoplogenus* sp., *Gonocephalum* sp., *Paratelphusa bouvieri* and *P. hydrodromus* and other crop pests such as *Nephotettix* sp., *Euborellia* sp., *Nectuid* larva, *Bombidion soborium*, *Scarites* sp. and *Sipalus* sp. were present in the stomachs. *Anopheles* sp. is also an important food item of this frog. Pests of stored food grains like *Sternolophus brachyacanthus*, *Melanotus hirticornis* and *Anomala chlorocarpa*, an important pest of cashew, were also found in the food spectrum. Other species found in the stomachs of *R. hexadactyla* included fish food organisms, prawns, fishes and some frogs. However, their numbers were very low.

R. hexadactyla is usually found in water and its aquatic habit is reflected by the large proportion of aquatic insects eaten by it. Movement of the prey attracts the attention of this frog, whose first reaction is to jump upon and swallow its prey, all in a single movement. The frog may detect the prey from some distance and then approach it in a series of bounds, the last leap being made onto its prey. The forelegs are used to push into the mouth any item which the frog may not be able to swallow completely.

DISCUSSION

The food spectrum obtained in the present investigation indicates that insects form the main diet. From the observations recorded in the present study, it is noticed that insects, spiders and crabs are the major food items of *R. hexadactyla*. Arthropods thus form the bulk of the diet. Amongst the arthropods, insects appear to be the most favoured food, some of the insects being of economic importance. Issac and Rege (1975) and Abdulali (1985) have reported that *R. tigerina* played a significant role in controlling agricultural and other pests in the field. Crabs were found in large numbers in the diet of *R. hexadactyla*. They are often seen in the paddy fields and cause damage to the bunds in the fields by boring holes in them. Crabs are considered as one of the major pests of paddy (Kadam and Patel 1960) and are known at certain stages of their life to feed on rice seedlings both before and after transplanting. The frog is thus useful in controlling the crab population harmful to agriculture. Some gastropods were also recorded from the stomachs of a few frogs. Vertebrate groups such as fishes, amphibians and reptiles were also recorded but there was no reason to believe that they formed regular items of the diet (see Andrews 1976).

The presence of stones, leaves and debris among the gut contents of *R. hexadactyla* may be the result of accidental ingestion. Vegetable matter occurred in many guts, but the quantity was small; it might have been inadvertently ingested with the food. The intake of pebbles and plant matter may be important in providing roughage as well as increasing grinding capacity for the total mass ingested. The presence of stones and vegetable matter in the guts of anurans has also been reported by earlier workers (Battish *et al.* 1989, Sreelatha *et al.* 1990, George *et al.* 1992).

Mondal (1970) observed that the "northern race" of *R. hexadactyla* was a herbivore while the "southern race" preferred animal food. The present study indicates that *R. hexadactyla* in Kuttanad is carnivorous, as noted by Andrews (1979).

The present study reaffirms that frogs are useful as control agents for various insect pests especially those which are considered as serious crop pests. Though frogs are opportunistic feeders, their feeding on many phytophagous insect pests does support their usefulness as biocontrol agents. This fact has been stressed by several earlier workers (Abdulali 1985, Battish *et al.* 1989, Sreelatha *et al.* 1990, Sally *et al.* 1992).

The decline in the population of frogs in Kuttanad due to commercial capture for their legs and the effect of pesticide residues in the area may be detrimental to crops, especially paddy.

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REFERENCES

- ABDULALI, H. (1985): On the export of frog legs from India. *J. Bombay nat. Hist. Soc.* 82(2): 347-375.
- ANDREWS, M.I. (1979): Food and feeding habits of *Rana hexadactyla* Lesson. *J. Bombay nat. Hist. Soc.* 76: 175-179.
- BATTISH, S.K. & J.S. SANDHU (1988): Food spectrum of the skipper frog *Rana cyanophlyctis* (Schneider). *Ann. Biol.* 4(1&2): 14-19.
- BATTISH, S.K., ANNU AGARWAL & PARAMJIT SINGH (1989): Food spectrum of the marbled toad, *Bufo stomaticus* Lutken. *J. Bombay nat. Hist. Soc.* 86: 22-31.
- BERRY, P.Y. (1965): The diet of some Singapore Anura. *J. Zool. London* 144: 163-174.
- BERRY, P.Y. (1970): The food of giant toad *Bufo asper*. *Zool. J. Linn. Soc. London* 49: 61-68.
- BLACKITH, R.M. & M.C.D. SPEIGHT (1974): Food and feeding habits of the frog *Rana temporaria* in the bogland habitats in the west of Ireland. *J. Zool. London* 172: 67-79.
- BROOKS, G.R. (1959): A Survey of the food habits of *Rana catesbeiana* from five different habitats. *Virginia J. Sci.* 10: 263.
- CHACKO, P.L. & B. KRISHNAMURTHY (1951): The food of *Rana hexadactyla* Lesson in relation to fisheries. *Sci. & Cult.* 15(10): 401-402.
- DRAKE, C.J. (1914): The food of *Rana pipiens* Schreber. *Ohio Nat.* 14: 257-269.
- GEORGE, SALLY, SANIL GEORGE, MANU OOMMEN & MARIAMMA JOHN (1992): Food spectrum of the frog *Rana limnocharis* (Boie in Weighmann). *J. Zool. Soc. Kerala* 2(1): 58-61.
- ISSAC, S. & M.S. REGE (1975): Food of *Rana tigerina* (Aud.). *J. Bombay nat. Hist. Soc.* 72(1): 143-157.
- JENSEN & W.D. KLIMSTRA (1966): Food habits of the green frog *Rana clamitans* in Southern Illinois. *Amer. Mid. Nat.* 76: 169-182.
- KADAM, M.V.B. & G.A. PATEL (1960): Crop pests and how to fight them. Div. Pub. Govt. Maharashtra.
- KHERA, K.L. (1975): Systematics and biology of anurans of North India with special references to biology of *Rana cyanophlyctis*. D. Phil., thesis, Punjab Univ., Chandigarh.
- MONDAL, A.K. (1970): On the distribution, occurrence, culture possibilities and food of *Rana hexadactyla* Lesson. *Sci. & Cult.* 36(3): 138-143.
- NEEDHAM, J.G. (1905): The summer food of the bull frog (*Rana catesbeiana*) at Saranac. *Bull. New York State Mus.* 86: 9-15.
- NIGAM, H.C. (1979): Food and feeding habits of *Rana tigerina* in paddy belts of U.P., India. *Geobios.* 6(6): 241-244.
- SMITH, M. (1953): The feeding habits of the marsh frog, *Rana ridibunda ridibunda*. *Brit. J. Herpet.* 1: 170-172.
- SREELATHA, K.S., P. NATARAJAN & S.D. RITA KUMARI (1990): Studies on the food and feeding behaviour of *Bufo melanostictus* Schneider. *J. Ecobiol.* 2(3): 213-221.
- TYLER, M.J. (1958): On the diet and feeding habits of the edible frog (*Rana esculenta* Linn.). *Proc. Zool. Soc. London* 131: 582-592.